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Title: Fundamental Studies on Intermetallic Aluminides

### •Research Objectives:

(i) To investigate the thermodynamic properties of intermetallic aluminides in the Ti-Al-X (X=Cr, V, Nb) systems using solid state galvanic cell and other equilibrium techniques (ii) To study the stability of various intermetallic phases in different environments such as oxidation and sulfidation

### •Approach

A solid state galvanic cell (EMF) will be setup to determine the thermodynamic properties in the Ti-Al-X systems. Stability of various phases will be studied by oxidation experiments and the resultant samples will be characterized using XRD, SEM, EDS techniques. Reaction mechanism will be elucidated and diffusion data will be generated. A typical galvanic cell is represented as:

Pt, gr/Al, Ca<sub>2</sub>AlF<sub>7</sub>||CaF<sub>2</sub>||Al(Ti-Al alloy), Ca<sub>2</sub>AlF<sub>7</sub>/gr, Pt

Overall cell reaction: Al (s) = Al (Ti-Al alloy).  $a_{Al} = \exp\left(\frac{-nFE}{RT}\right)$

Diffusion data will be analyzed by the following equations:

$$\alpha^2 = K_p t$$

$$D = \frac{K_p x_o^2 Z}{2\Delta cv}$$

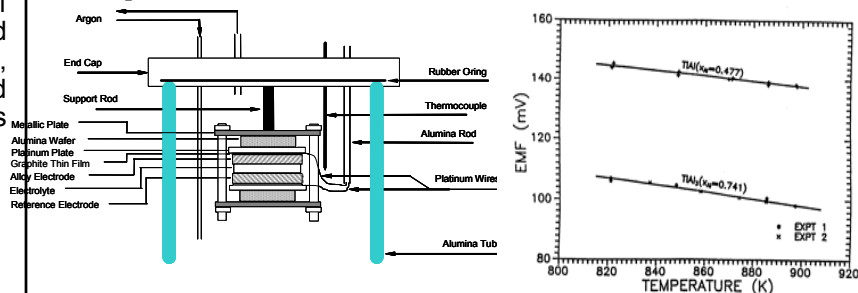
### •Broader Impact:

The successful completion of this research will improve our understanding of phase stability in advanced materials under diverse environmental conditions and provide a basis for the development of new intermetallic compounds. The mechanism of the oxide multilayer formation will enable us to grow nanoscale layers, which is a new technology

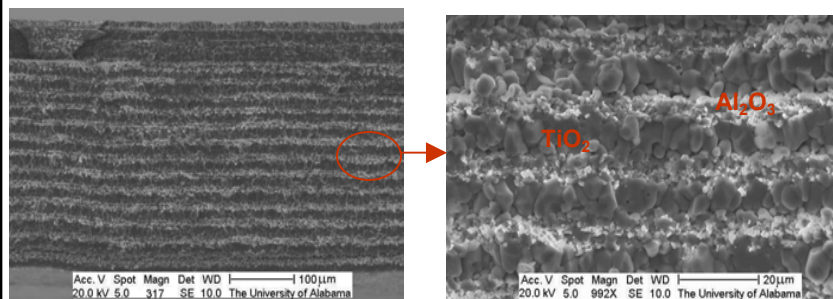
### •Significant Results:

Thermodynamic properties of the Ti-Al system were calculated and results indicate strong negative deviation from ideality. Oxide multilayers with alternate layers of Al<sub>2</sub>O<sub>3</sub> and TiO<sub>2</sub> were formed with an average layer thickness of <10 μm on Ti-30Al-3Nb alloy oxidized at 1373 K. Difference in diffusivities of O, Ti, Al and Nb could be the reason for these multilayer formation.

### •Graphic:



EMF cell setup and experimental results for two Ti-Al alloys



SEM pictures of in-situ metal oxide multilayers